Enterprise Architectural Patterns for Command and Control

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Summary

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Introduction

- **LM-MS Is On Contract to Evolve a Network of 40 Separate Command and Control Systems Into a 21st Century Enterprise Architecture**
  - **Legacy Systems Have Provided Reliable, Unambiguous Mission Capabilities for Decades**
  - **Extremely Expensive Sustainment Costs Led to Procurement of Enterprise System Developer**
  - **Evolution to Enterprise Architecture Must Occur in Manageable, Affordable Steps that Provide Continuous Proof of Concept as Well as Continuous Mission Capability**
  - **Legacy Systems Are Truly Complex (Tens of Millions of SLOC, Hundreds of Message Types)**

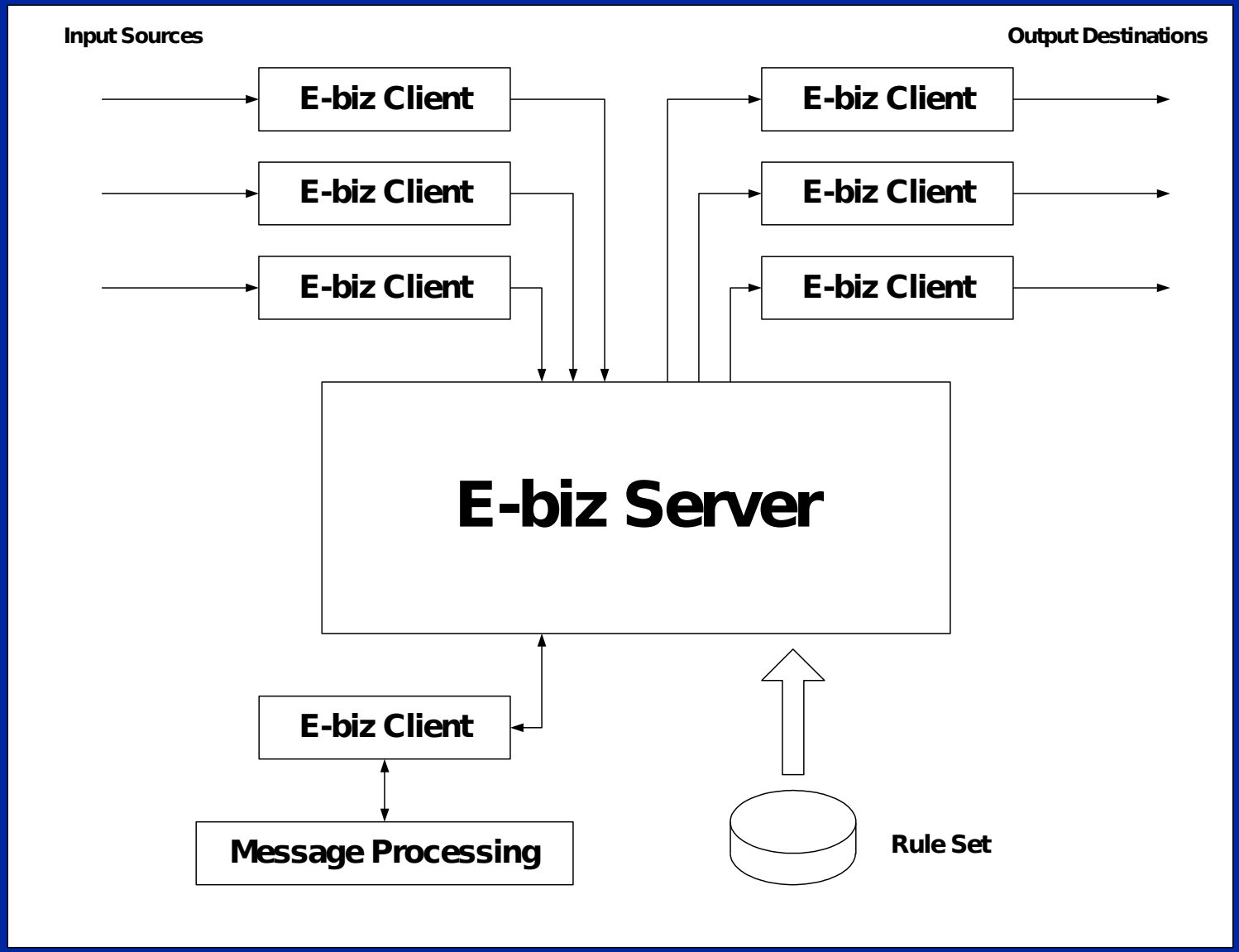
Contract and Customer Goals

- Customer Has Identified Key Goals
  - GCCS Interoperability at Multiple LISI Levels
  - Compliance With COE
  - Commercial Technology With Timely Refresh
  - Evolutionary Improvements With Continuous Mission Integrity (Accuracy, Reliability, Timeliness, and Unambiguity)
  - A Common Enterprise Database For All Missions
  - A Single Enterprise Workstation For All Mission Positions
- This Presentation Presents Several Patterns Useful for Complex Enterprise Engineering

Message Processing Pattern

- Legacy Systems Employ Custom Message Set
  - Hundreds of Unique, Extremely Bit Efficient Formats
  - Codify Significant Problem Space Knowledge
  - Consume Significant Share of Sustainment Budget
- We Are Using IBM E-biz Integrator As Off-The-Shelf Solution
  - Client-Server Model With Centralized Message Loop and Interface Adapters, Including Vendor Standards
  - Clients Connect To Messages, Databases, Methods
  - Rule-Based Parsing and Processing Specification
  - Transaction Protection To Assure Mission Integrity

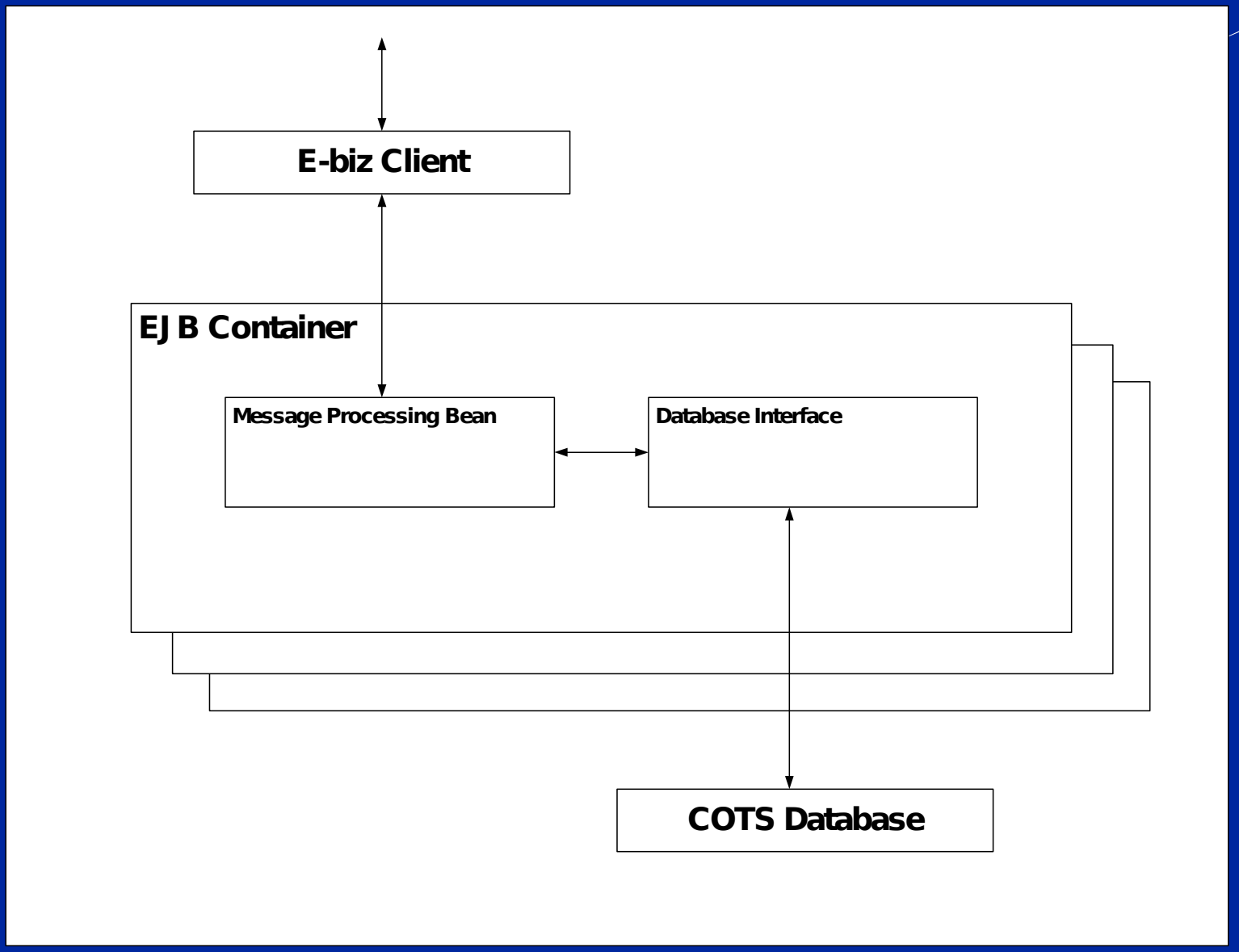
Message Processing Pattern



Mission Processing Elements

- One Message Represents One Atomic Set of Updates To Our System
  - E-Biz Places a Parsed Message in a Guaranteed Delivery Queue
  - Each Message is Processed as a Single Distributed Transaction by a Message Processing Enterprise Java Bean (EJB)
  - If Hardware or Software Fails, the Transaction is Rolled Back and Reprocessed
  - Currently, Messages Must Be Processed Serially
  - Use of EJBs Allow Evolution to Concurrent Message Processing When Possible

Mission Processing Elements



Enterprise Database Pattern

- **Legacy Systems Each Have Their Own Data Sets, Data Representations, and Technology**
  - **Message Centric Approach Creates Islands of Incompatible Data and Technology**
- **Customer Vision Is an Enterprise Database**
  - **Singular Representation and Storage**
  - **Interoperable with Other DoD Systems and Standards**
  - **Several Behavioral Patterns for Data Access**
    - Largely Static Data Loaded at Initialization
    - Mostly Static Data Loaded, Reloaded If Changes
    - Mostly Dynamic Data Loaded, Publish-Subscribe Changes

Vendor-Independent Technology

- Legacy Systems Exhibit Vendor Lock
  - Degrades Maintainability and Flexibility
- Insistence on Open Standards in Enterprise
  - Non-Proprietary, Supported by Multiple Vendors
  - Standards From National or World Authorities
  - Scalable In Size, Number, and Speed
- Consciously Avoid Proprietary Standards
  - Examples: Sun Clustering, Microsoft .NET
  - Counterexample: Oracle Providing Highly Available SQL Service Atop Sun Clustering

MAPE Loop Functional Definition

- Our Customer Has Identified a Simple, Extensible Paradigm for the Specification of System Behavior and Interaction
  - Monitor, Assess, Plan, and Execute (MAPE) Loop
  - Most System Functionality Can Be Included
- Non-DoD Enterprises Will Benefit From a Simple, Universal Behavioral Paradigm
  - Many Enterprise Environments Are Not as Tightly Constrained as Those Used for DoD Missions
  - Any Framework Is Better Than No Framework

Generic Introspective Components

- Command and Control Systems Define Complex Mission Objects and Also Require Generic Service Capabilities
  - Inheritance-Based Services Tend to Grow in Number and Complexity
  - Java Introspection and Reflection Allow the Definition of Truly Universal Services Which Can Accommodate Mission Objects
  - No Dependencies Against Mission Objects
  - Reflection Overhead Can Be Minimized By Storing Field Instances Upon First Use

Dual Operations

- Our Customer Builds Two Systems At Once
  - The Real System, 24x7 With Backups
  - An Exercise or Test Capability, Equally Sized
- Support for Realistic Test and Training
- Used to Roll In New Versions Without Downtime
  - Install New Version on Exercise/Test Capacity
  - Run In Parallel Until Satisfied
  - Declare New Version Operational
- Cost-Effective If Mission Integrity Is Essential

Enterprise Process Perspective

- Enterprise Construction Requires Creativity With Traditional DoD Contracting Techniques
  - Waterfall Construction Is Infeasible, Yet Contracts Must Have Statements of Work
  - Our Horizon Is Nearly a Decade Away, But Our Contractual Documents Cover Only Two Years
  - An Annual Master Evolution Spiral Review (MESR) Brings All Stakeholders Together To Build Compromises for the Hard Decisions
- Proper Balance of High Tech, High Touch, and High Finance

Conclusion

- **The DoD Is Adapting to the Necessity of Enterprise Construction Contracts**
  - **Only A Dynamic Enterprise Construction Paradigm Can Stay Abreast of Technology and Politics**
  - **Staying Sold Is At Least As Important as Staying Mainstream**
- **Mission Success Is Still Our Bottom Line**
  - **DoD Missions Have More At Stake**
  - **Mission Success 24x7 In the Command Center**
  - **Mission Success With A Satisfied, Successful Customer, Year After Year**